Design Course

Materials and Processes

The Science of Material Selection

by
Prof. B. K. Chakravarthy
IDC, IIT Bombay

Source:
https://www.dsource.in/course/materials-and-processes

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2. Case Studies
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Introduction

Objectives Of The Course:
- Basic Knowledge to Expert Knowledge
- Outside - In Method
- Learning through Actions
- Basic to Futuristic
- Concept Evolution based on Material and
- Manufacturing Constraints
- Forecasting

Course Structure:
The course was a blend of lectures, studio work and industry visits. It was structured as follows:
1. Class Lectures ID 647
2. Case Study Presentations
3. Studio Assignments
4. Central Library Assignment
5. Design of Products for Materials
6. Industrial Visits

1. Class Lectures ID 647

- Study of Plastic and Plastic Processes
    - Thermosets

    According to IUPAC recommendation: A thermosetting polymer is a prepolymer in a soft solid or viscous state that changes irreversibly into an infusible, insoluble polymer network by curing. Curing can be induced by the action of heat or suitable radiation, or both. A cured thermosetting polymer is called a thermoset.

    - Thermoplastics

    A Thermoplastic, also known as a thermosoftening plastic, is a polymer that becomes pliable or mold able above a specific temperature, and returns to a solid state upon cooling. Most thermoplastics have a high molecular weight, whose chains associate through intermolecular forces; this property allows thermoplastics to be remolded because the intermolecular interactions spontaneously reform upon cooling. In this way, thermoplastics differ from thermosetting polymers, which form irreversible chemical bonds during the curing process; thermoset bonds break down upon melting and do not reform upon cooling.

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- Classification of Thermoplastics andThermosets
    - Acrylics
    - Cellulosics
    - Polyamides
    - Polyolefins
    - Styrenes
    - Vinyls

- Molding Processes
    - Blow molding

Blow molding (also known as blow moulding or blow forming) is a manufacturing process by which hollow plastic parts are formed. In general, there are three main types of blow molding: ex trusion blow molding, injection blow molding, and stretch blow molding. The blow molding process begins with melting down the plastic and forming it into a parison or preform. The parison is a tube-like piece of plastic with a hole in one end in which compressed air can pass through. The parison is then clamped into a mold and air is pumped into it. The air pressure then pushes the plastic out to match the mold. Once the plastic has cooled and hardened the mold opens up and the part is ejected.

- Compaction plus sintering

- Compression molding

Compression molding is a method of molding in which the molding material, generally preheated, is first placed in an open, heated mold cavity. The mold is closed with a top force or plug member, pressure is applied to force the material into contact with all mold areas, while heat and pressure are maintained until the molding material has cured.
The process employs thermosetting resins in a partially cured stage, either in the form of granules, putty-like masses, or preforms. Compression molding is a high-volume, high-pressure method suitable for molding complex, high-strength fiberglass reinforcements.

Advanced composite thermoplastics can also be compression molded with unidirectional tapes, woven fabrics, randomly oriented fiber mat or chopped strand. The advantage of compression molding is its ability to mold large, fairly intricate parts. Also, it is one of the lowest cost molding methods compared with other methods such as transfer molding and injection molding;

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moreover it wastes relatively little material, giving it an advantage when working with expensive compounds.

However, compression molding often provides poor product consistency and difficulty in controlling flashing, and it is not suitable for some types of parts. Fewer knit lines are produced and a smaller amount of fiber-length degradation is noticeable when compared to injection molding. Compression-molding is also suitable for ultra-large basic shape production in sizes beyond the capacity of extrusion techniques. Materials that are typically manufactured through compression molding include: Polyester fiberglass resin systems (SMC/BMC), Torlon, Vespel, Poly(p-phenylene sulfide) (PPS), and many grades of PEEK.

- Compaction plus sintering
- Extrusion molding
- Foam molding
- Injection molding
- Laminating
- Reaction injection molding
- Matched mold
- Matrix molding
- Plastic moulding
- Pressure plug assist molding
- Rotational molding (or Rotomolding)
- Transfer molding
- Thermoforming
- Vacuum forming, a simplified version of thermoforming
- Vacuum plug assist molding

- Mold Design and Processing

- Holes and Undercuts

In manufacturing, an undercut is a special type of recessed surface. In turning it refers to a recess in a diameter. In machining it refers to a recess in a corner. In molding it refers to a feature that cannot be molded using only a single pull mold. In printed circuit board construction it refers to the portion of the wafer that is etched away under the photoresist.

- Inserts

Inserts are pins, bolts, screws, joints and other structures that are used to transfer localized loads to a

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composite panel or to join two composite panels together.

• Fastening and Joining
The Fastening and Joining section features information about welding, adhesives, soldering, brazing, nuts, bolts, and rivets.

• Composites
Composite materials, often shortened to composites or called composition materials, are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct within the finished structure. A common example of a composite would be disc brake pads, which consist of hard ceramic particles embedded in soft metal matrix. Another example is found in shower stalls and bathtubs, which are made of fiberglass. Imitation granite and cultured marble sinks and countertops are also widely used. The most advanced examples perform routinely on spacecraft in demanding environments.

• Design in Plastics

• Understanding the design requirements in plastic

• Study of Ferrous and Non-Ferrous Metals

• Casting, Core Making, Curing
Casting is a manufacturing process by which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various cold setting materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.

• Bending
Bending is a manufacturing process that produces a V-shape, U-shape, or channel shape along a straight axis in ductile materials, most commonly sheet metal. [1] Commonly used equipment include box and pan brakes, brake presses, and other specialized machine presses. Typical products that are made like this are boxes such as electrical enclosures and rectangular ductwork.

• Deep Drawing
Deep drawing is a sheet metal forming process in which a sheet metal blank is radially drawn into a forming die by the mechanical action of a punch. [1] It is thus a shape transformation process with

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material retention. The process is considered "deep" drawing when the depth of the drawn part exceeds its diameter. This is achieved by redrawing the part through a series of dies. The flange region (sheet metal in the die shoulder area) experiences a radial drawing stress and a tangential compressive stress due to the material retention property. These compressive stresses (hoop stresses) result in flange wrinkles (wrinkles of the first order). Wrinkles can be prevented by using a blank holder, the function of which is to facilitate controlled material flow into the die radius.

• Forging
Forging is a manufacturing process involving the shaping of metal using localized compressive forces. Forging is often classified according to the temperature at which it is performed: "cold", "warm", or "hot" forging. Forged parts can range in weight from less than a kilogram to 580 metric tons. Forged parts usually require further processing to achieve a finished part.

• Machining
Conventional machining is a form of subtractive manufacturing, in which a collection of material-working processes utilizing power-driven machine tools, such as saws, lathes, milling machines, and drill presses, are used with a sharp cutting tool to physically remove material to achieve a desired geometry. Machining is a part of the manufacture of many metal products, but it can also be used on materials such as wood, plastic, ceramic, and composites.

• Study of Mechanisms and Linkages
  • Basic Engineering Concepts
  • Mechanical Concepts
  • Concepts of Basic Physics
  • Fixers
  • Cams

• Design in Plastic
• Basics of Design and Technology

2. Case Study Presentations

• Z-line Petrol Pump
• Post Box Design
• Samsonite Suitcase
• Back Hoe Loader

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3. Studio Assignments

- Low Cost Toy Analysis: Focus on Economic Considerations
- Vehicle Disassembly:
- Comparison of materials across different vehicles
- Study of various elements like chassis, seat and fixing details
- Application Development in stainless steel

4. Central Library Assignment

- Use of futuristic materials in new products
- Scanning all journals and online journals

5. Design of Products for Materials

- Redesign of an existing product in five different materials with focus on change in design due to change of material.

6. Industrial Visits

- Plywood Industry
- Rubber Industry
- Plastic Industry
- Godrej
- Mahindra and Mahindra
- Midco

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Case Studies

Historical View:
Materials and manufacturing processes have developed over the time. A historical study of product evolution reveals that products have evolved around the availability of materials and processes. Following examples illustrate how development in metal manufacturing technologies influenced product design.

1857 – A cast iron post box made of 15 - 20 mm thick walls. At this time metallurgy was not well developed. This box is not portable due to its sheer weight.By 1859, metallurgy techniques were improved significantly, as is evident from the detailed decorations on the post box. Also the thickness comes down to 4-6 mm.

UK 1857

UK 1859

UK 1866

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With the advent of newer materials like sheet metal and improvement in manufacturing techniques, the design of the letterbox evolved into a newer form. The last box from 1992 is no longer in cast iron, but in sheet metal. Hence a significant form change is visible because of material and manufacturing process change.

Influence of Contemporary Products:
The images show how fuel dispensers' form & materials have evolved with car form. The car from 1924 is a minimalist means of transportation. So is the fuel dispenser. By the advent of 1954, car manufacturing has become more sophisticated. The fuel dispenser is also now made in sheet metal rather than casting. The fuel dispenser body is more boxy similar to the car form.

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Cultural/ Market Influence:
The 1st pump is from USA where the consumer had very sophisticated choices regarding the composition of the fuel they would like to have. Also the prices vary across the choices. The 2nd pump is from Japan, which again sports minimal design that is more contextual to their culture.

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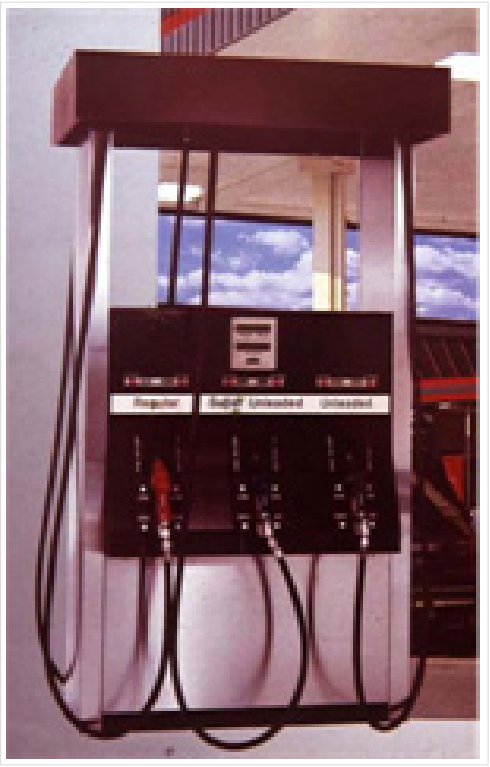

The evolution of fuel dispensers in India is shown below. The 1st dispenser is from the late 80s and early 90s, which saw a very simple market demand of petrol and diesel. Also the number of vehicles on road was much less. As the market matured in the country, different grades of fuel came in. Also the increase in the number of vehicles on the road made it essential to have a faster fueling station. Hence a single dispenser now has to handle more number of products. Thus the design evolved as per the need of the market. Through the years sheet metal production in the country started and fabrication facilities cropped up. This influence is also visible in the product design. The Oval dispenser shows how branding can be a product design driver. ONGC wanted to show its brand image and market leadership position depicted through the product. Producing the form was possible at a low cost due to manufacturing innovations in the field of welding.

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Awareness of Manufacturing Capability:
Thus it is very important for a designer to know the manufacturing capabilities of his company as well as that provided by the market in which one is operating. This helps to produce best quality product at a competitive price.

For example, while the Z-line was being designed in the 1989, L&T possessed high-tech Amada CNC machines, which could produce highly accurate sheet metal components. Similar facilities were hardly available elsewhere in the country. Thus the design of Z-line uses the machine to the best of its capability. It took more than a month to program the machine to make the sloping part.

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The electronic compartment of the dispenser needs to be water ingress proof. Using gaskets can do this. But to manufacture gasket as per the need of the product was turning out to be more expensive. But thanks to the advent of Maruti in the country at that time, a huge gasket manufacturing industry was launched. Thus Z-line used the same gasket, which was very cheap now due to large volume productions, but at the same time was very high quality. The assembly was inspired by the car industry too. 5% cost saving was brought in this way.

Ideation:
The images below show how considering different materials and processes influences the ideation process for a product.

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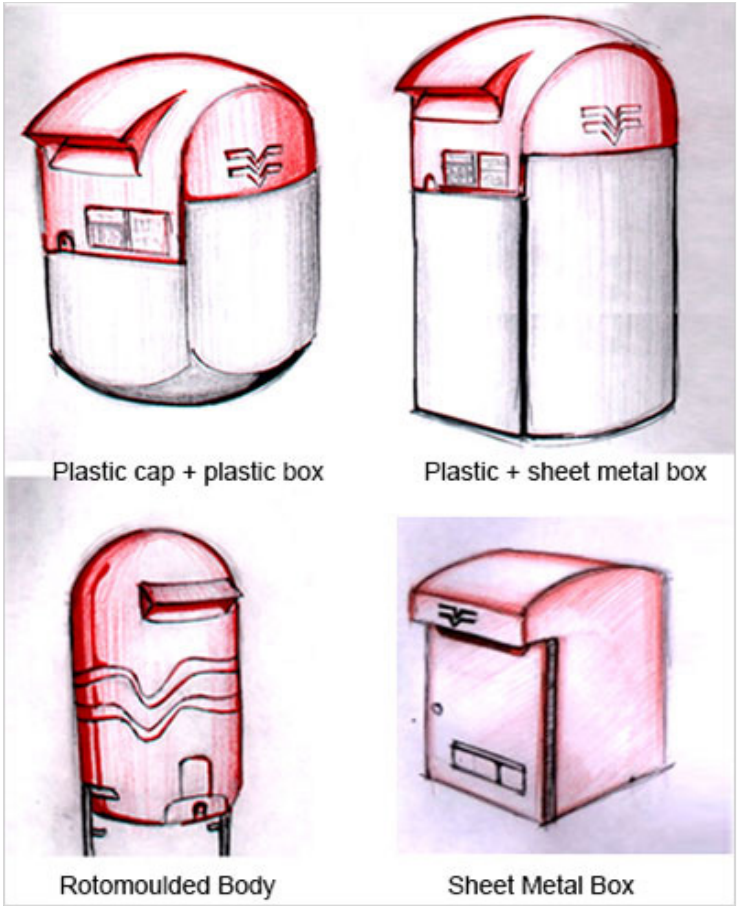

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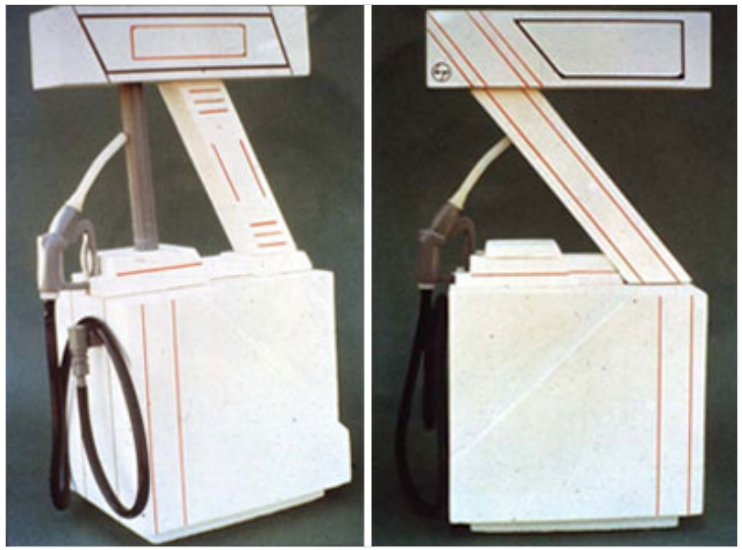
Visual Elements: Importance of Visual Strength and Balance:



Removal of the wire routing rod from the 1st mock-up drastically changes the formal appeal of the product. But at the same time changes the manufacturing challenges.

Integration of form and function: Modular Design:
The pump has both a LED and LCD displaying the same information. This is a very contextual design for Indian market where the pumps didn't have a top canopy. Hence the LEDs were not visible in the daytime whereas LCDs were not visible at night, as it is not glowing. This was a shock for the international market but very well suited to the local context. The tenders released by the oil companies thus had this basic requirement, which could not be fulfilled by any of the international companies.

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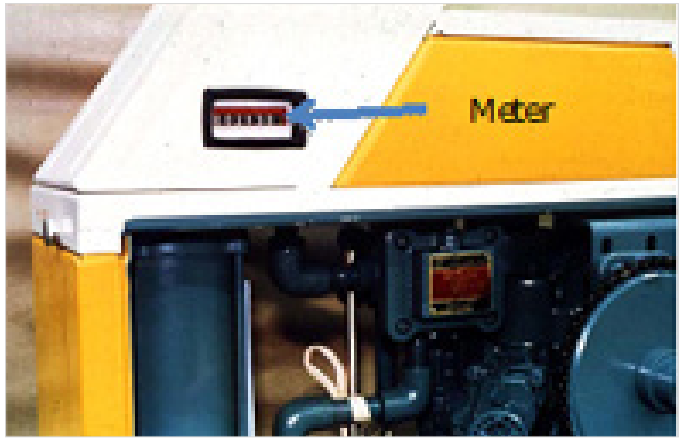
User Centric Approach: Different Levels of Users:

During the field research, it was observed that one of the pump's display was kept on the floor for maintenance and a scooter hit it and broke it. This insight was used to design this innovative hinge system for the display.



The meter is used by pump owners to see the total at the end of the day. Earlier it was placed inside and hence the pump owner had to use a torch and get in to see it. Z-line on the other hand made it user friendly by putting it on the front by using a universal coupling.

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Industry Visit

Industry visits are a very important component of the learning process. It gives the students an experience in seeing the process that initiates at the design table, then goes prototyping and testing, thereafter tooling, manufacturing and assembly.

1. Product Based Companies
2. Process Based Companies

1. Product Based Companies:
- 1.1 Mahindra and Mahindra
- 1.2 Godrej Furniture Division
- 1.3 MIDCO

1.1 Mahindra and Mahindra:

- Casting - Sand gravity casting, Core making,
- Ramming, Curing, Making molten metal infurnace, pouring, Sprue, gates, runners.
- Gear hobbing
- Engine Assembly Line
- Vehicle Assembly Line
- Differential Transmission Assembly
- Gearbox Assembly
- Engine Testing
- Gearbox testing

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- Painting
- Underbody inspection

1.2 Godrej Furniture Division:

- Robotic welding
- Honeycomb Packing
- Bending of tubes
- Foam Forming
- Testing of chairs
- Assembly of Chair
- CNC sheet bending
- Plywood Routing
- Packaging system
- Visit to Design Cell - Chairs and tables for offices, Auditoriums, Parks, Homes

1.3 MIDCO:

- salient features of the pump
- Chassis Assembled Petrol pump
- Silicon Sealants

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- Cladding as per user requirements
- Testing of pump
- Testing of multi dispenser fuel pump
- Vinyl sticker application
- Side panels with bending, no welding
- Optional pumpless system

2. Process Based Companies:
- 2.1 Mould Making
- 2.2 Wood Industry
- 2.3 Rubber Industry

2.1 Mould Making:

Our electric screw drive injection moulding machine made in 1968.

- Injection Moulding
- Blow Moulding
- Electric Discharge Machining (EDM)
- Wire EDM
- Sand Blasting
- Mould surface Etching
- CNC die making

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2.2 Wood Industry:

- Manufacturing of decorative veneer
- Mass produced plywood
- Stitchless joining
- Treatment of wood

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2.3 Rubber Industry:

- Mixing of raw rubber with additives
- Compression moulding
- Analysis of rubber
- Types of rubber

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Studio Assignments

The Assignment:
Different assignments were given to the students so that they can get hands on experience on different materials and processes. The assignments were to first dismantle a simple toy and study the components. Thereafter three different brands of two-wheelers were disassembled and studied. Next the students designed various products to be manufactured using stainless steel. Last assignment was to search for exemplary products that have achieved their strength through an intelligent use of materials and processes.

1. Low Cost Toy Analysis
2. Vehicle Study
3. Application Development in stainless steel
4. Designs for Materials - Best Product Design Examples

1. Low Cost Toy Analysis:
Select any toy and analyze it with respect to the following aspects –

- Material and process of components
- Economic considerations
- Fixing details
- Mechanisms

The students chose simple toys. The toys had minimum mechanism, and thus the details, materials and processes could be given appropriate importance. A much better understanding of basic materials and processes was garnered through this exercise. This was especially true in case of plastic as a material since most of the toys today are made in cheap plastic, usually polypropylene or polyethylene. Thus, basic techniques of plastics, like bosses, fillets, ribs, screw fitting, press fitting etc were understood. Also, basic mechanisms for converting one form of energy into another were studied. Springs were the basic component in most of these mechanisms. Spiral Springs, coil springs, helical springs were thus comprehended. A very cost effective method of manufacturing was seen, as the toy industry is very competitive.

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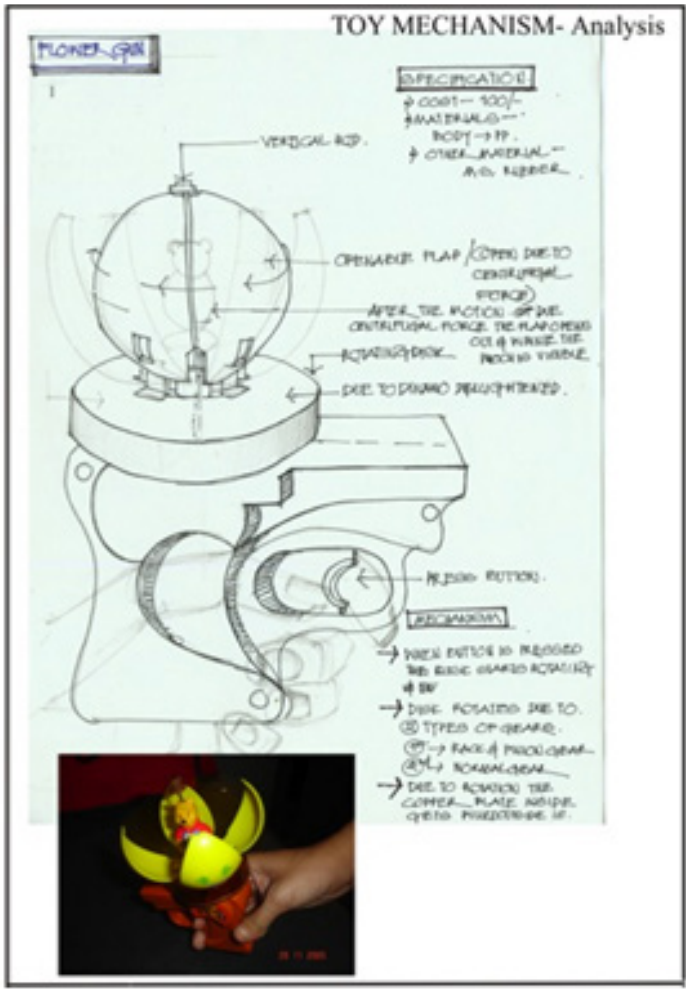
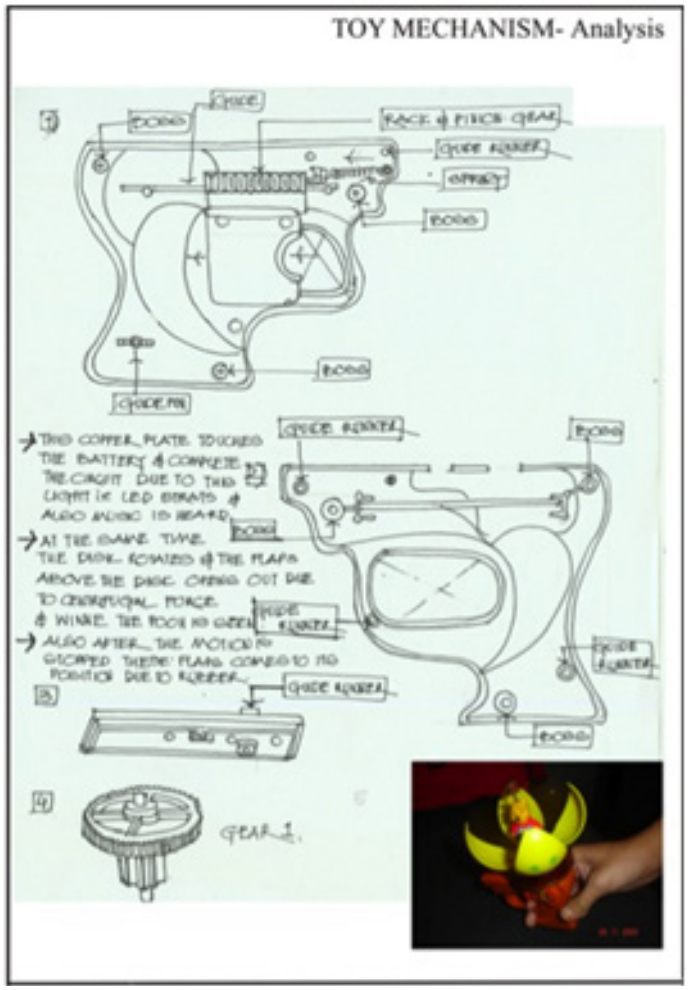
a. Flower Gun:





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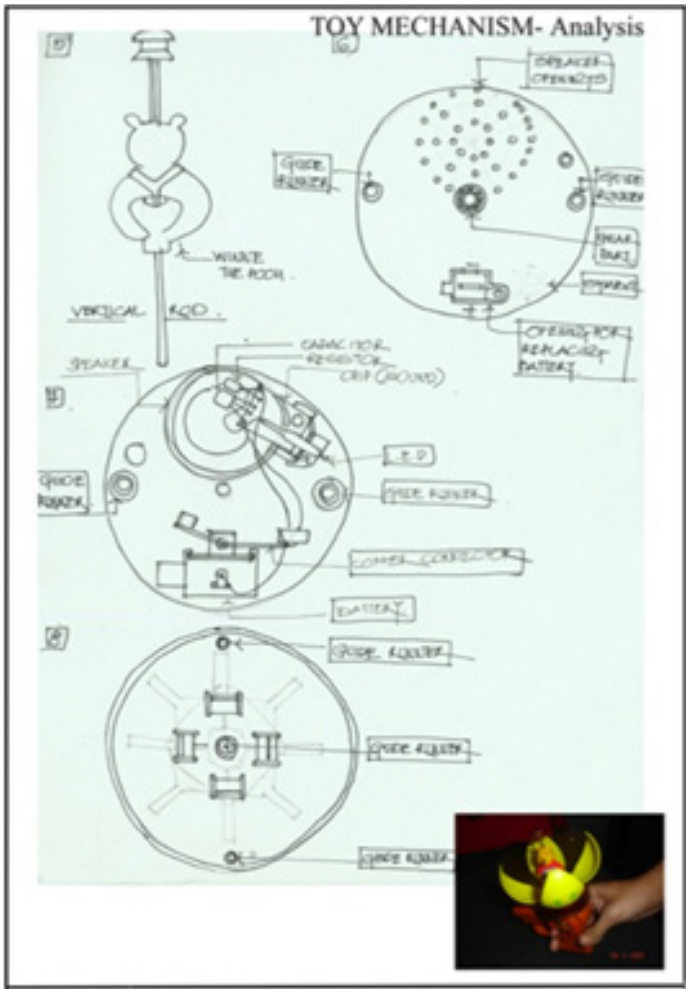

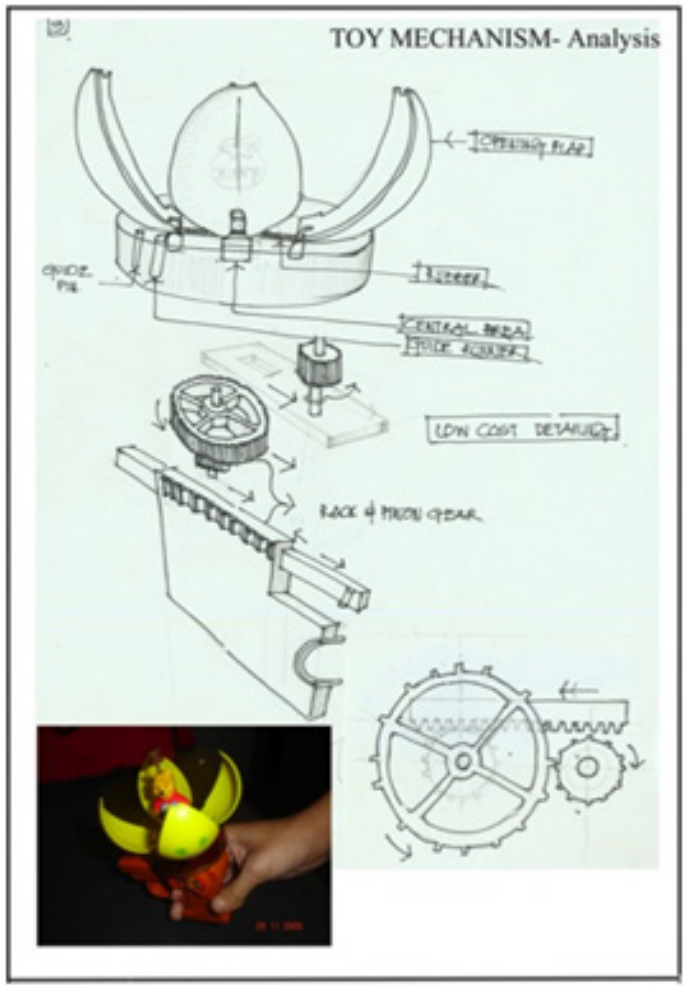

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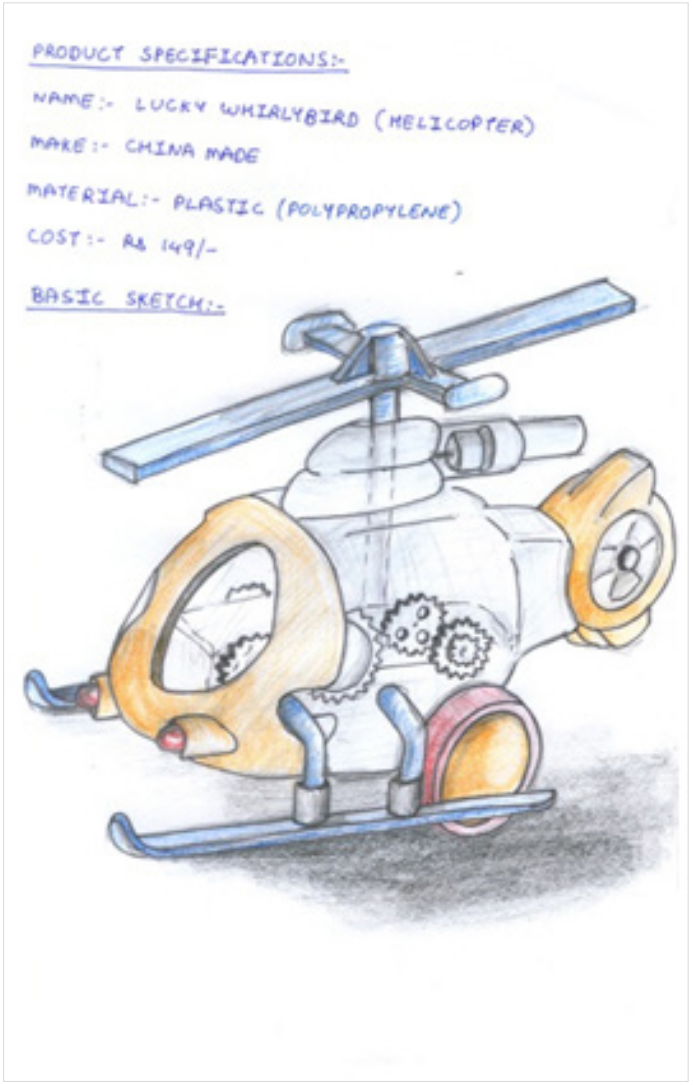
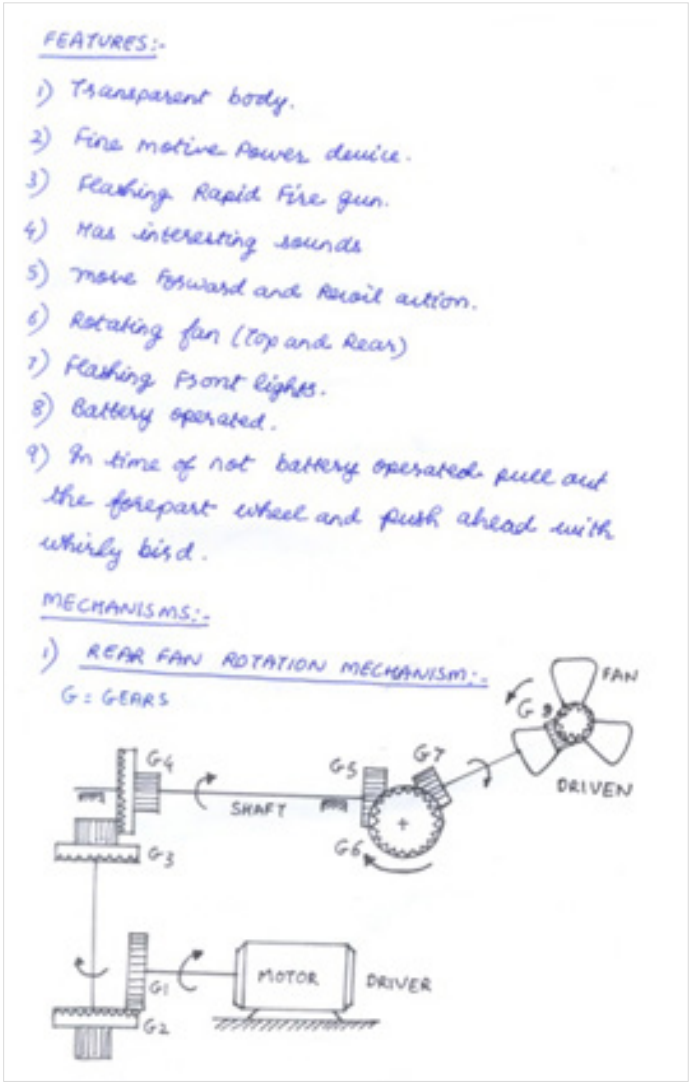
b. Helicopter:





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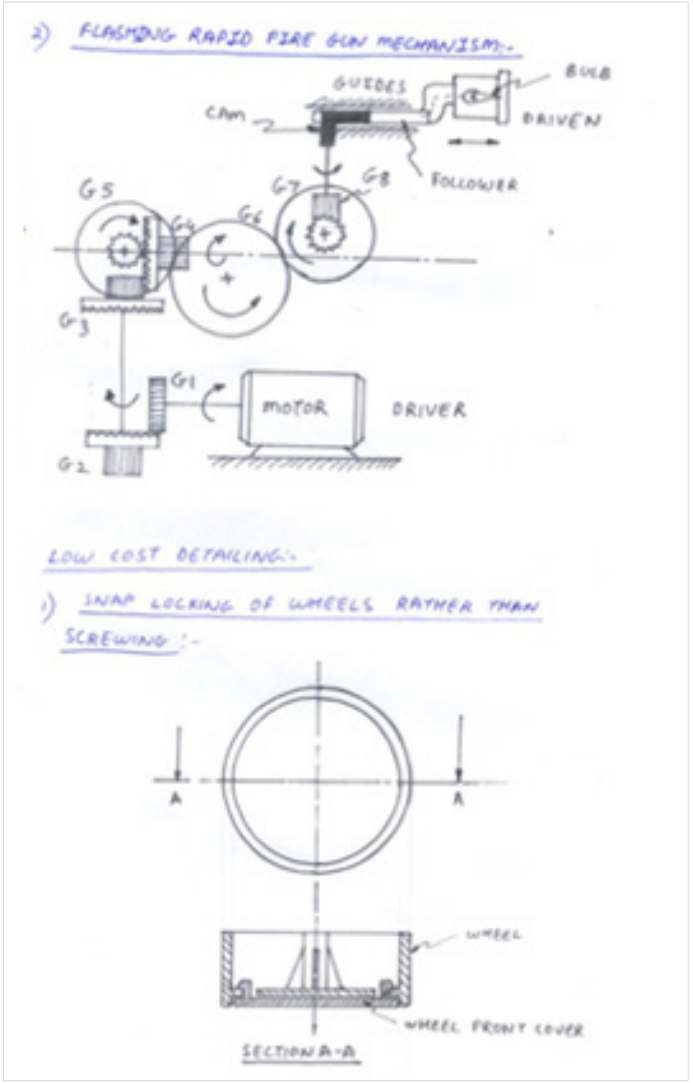

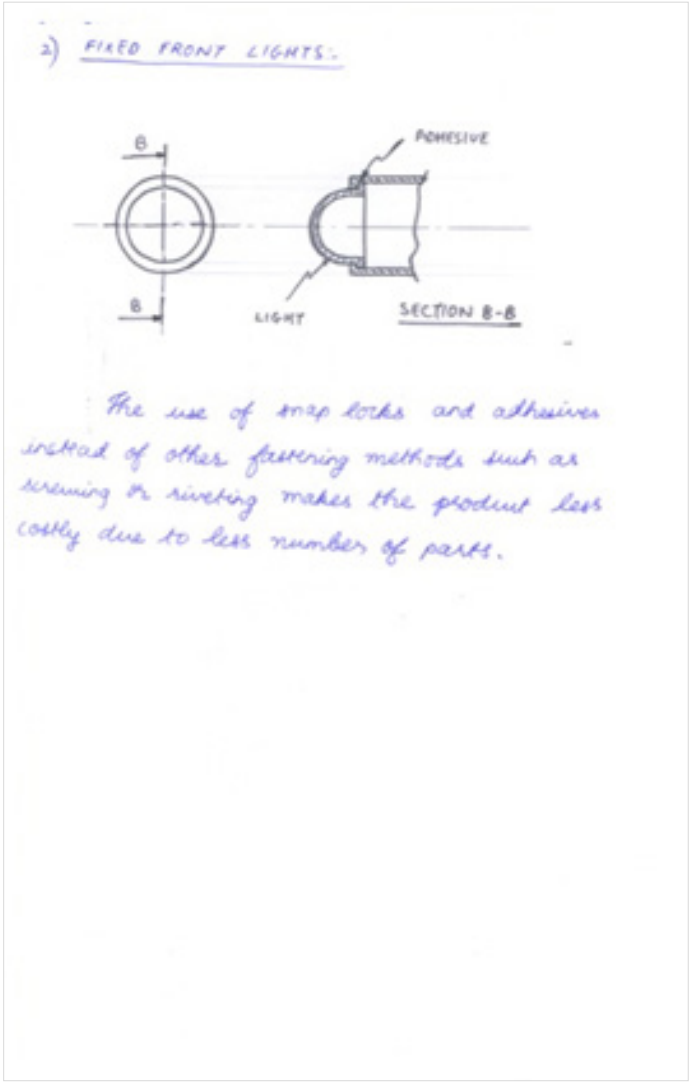
2) FIXED FRONT LIGHTS:-
B
B
ADHESIVE
LIGHT
SECTION B-B
The use of snap locks and adhesives instead of other fastening methods such as screwing or riveting makes the product less costly due to less number of parts.

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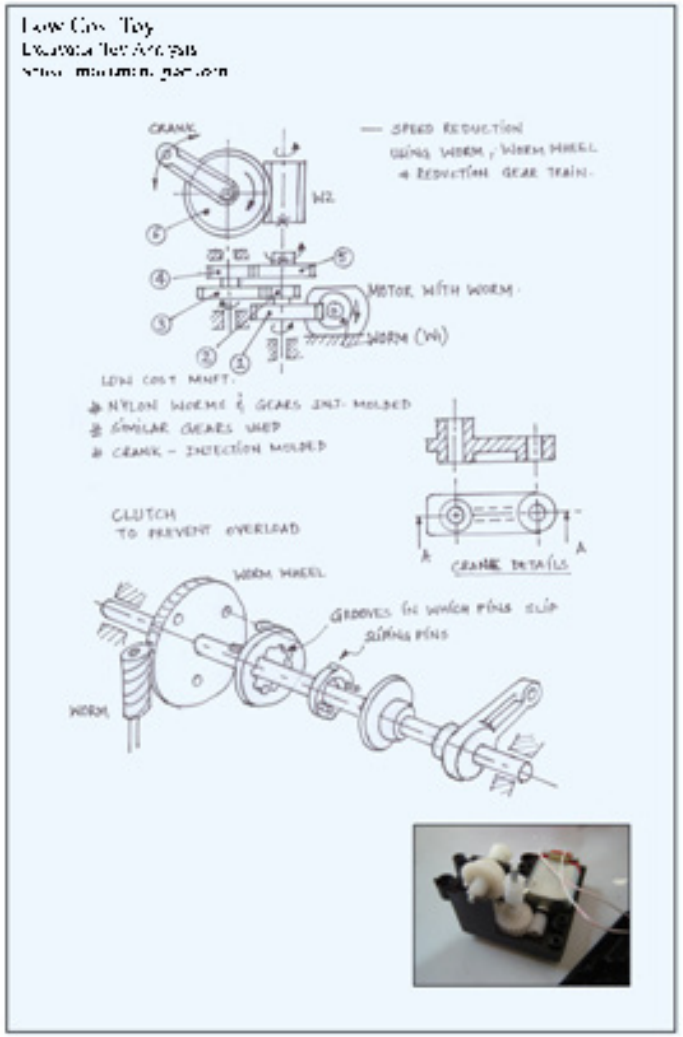
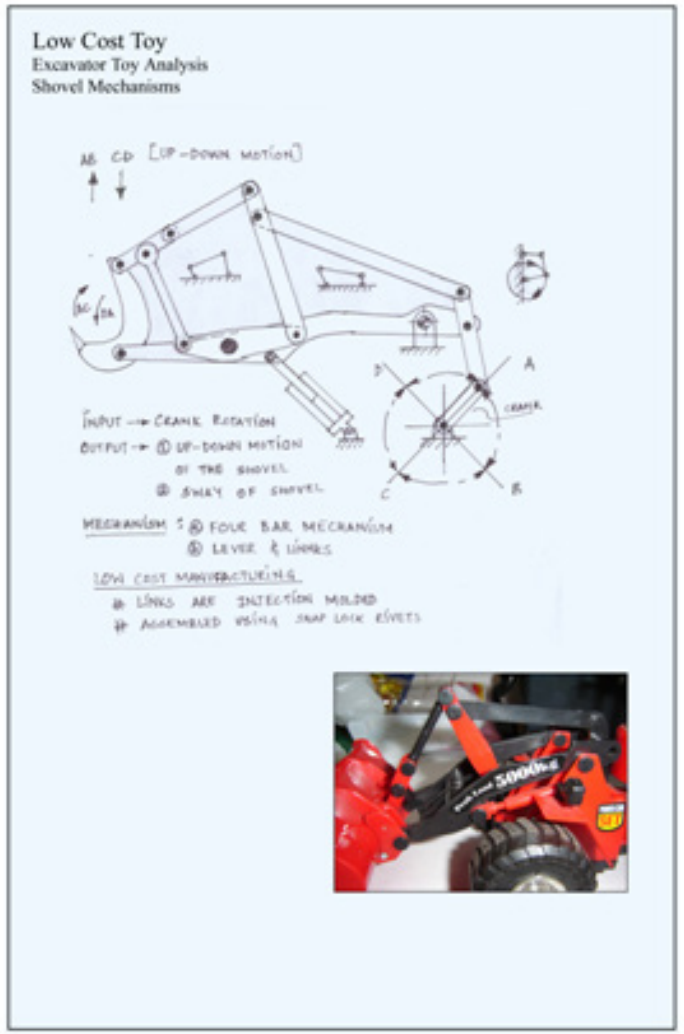
c. Excavator Toy:




Low Cost Toy
Excavator Toy Analysis
Shovel Mechanisms
AB, CD [UP-DOWN MOTION]
INPUT → CRANK ROTATION
OUTPUT → ① UP-DOWN MOTION OF THE SHOVEL
② SWAY OF SHOVEL
MECHANISM : ① FOUR BAR MECHANISM
② LEVER & LINKS
LOW COST MANUFACTURING
LINKS ARE INJECTION MOLDED
ASSEMBLED USING SNAP LOCK RIVETS

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2. Vehicle Study:
Aim - Learning Materials and Processes the experiential way
Step 1

- Disassembly of two-wheelers - Vespa, Scooty and Hero Puch
- Identifying the various materials used in different components of the two-wheelers
- Understanding design details, manufacturing details, material details, fixtures and cross-sections
- Suitability of the material and processes depending on various constraints like,
    - Volume of production
    - Volume of production

Step 2

- Comparisons of following components
    - Seats
    - Chassis type
    - Methods of fastening

Following images show the key findings of the assignment.

Disassembled Vehicle

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Seats:
The Seats of Vespa and Hero Puch were deep drawn whereas the seat of Scooty is injection molded.The foam in each case, which is used to give comfort, is heated and molded.

Chassis type:
The TVS Scooty has a chassis, which is made of sections welded and bolted together. The body of the Hero Puch is constructed from sheet metal welded together whereas the body of LML Vespa is essentially a monocoque structure.

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Methods of fastening:
The various components are welded to the chassis by arc welding. The engine is attached to the body using an axial bolt and nut in each case. In parts where maintenance is required during use, removable fastenings are used.

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3. Application Development in stainless steel:

Step1: Understanding properties of SS

- Hygienic
- Maintains Luster
- Rust Free
- Work Hardening

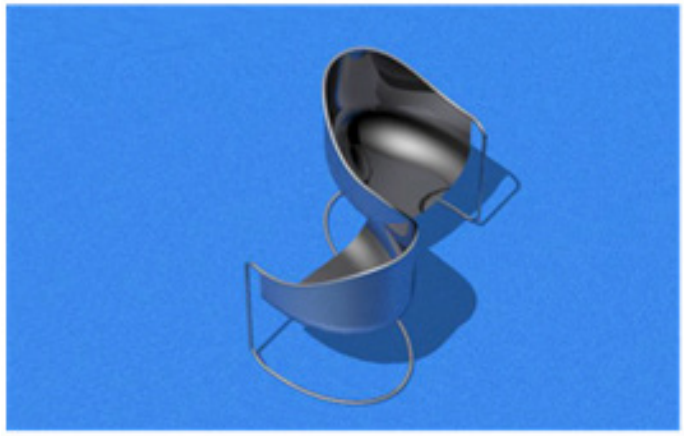
Step 2: Manufacturing processes

- Bending
- Punching
- Forming
- Welding
- Deep Drawing

Step 3: Design

Aesthetics
Functions
Lifestyle
Products developed by students are shown below:

1. A seating system designed in Stainless steel:



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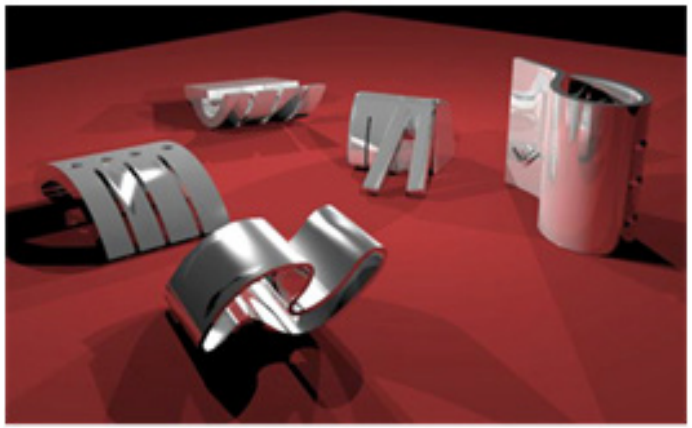
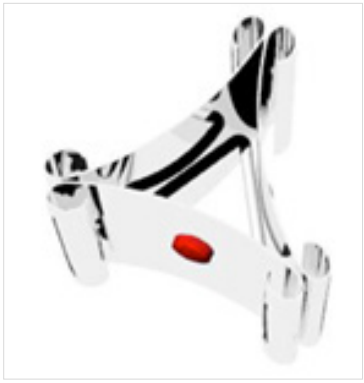
2. Desktop Lifestyle Products:



Desk clock, card holders, paperweights and penholders

3. Clips:



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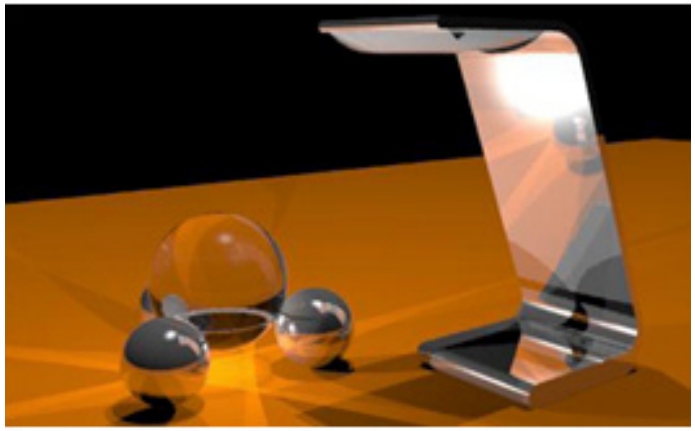
4. Lamps:



5. Murals:

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4. Designs for Materials - Best Product Design Examples:
Successful products display an exemplary use of materials and details in their design. Such products were studied to understand how different materials were used to satisfy the product requirements.

It was also observed how small additions of other materialscould play a vital role for the success of the product.

a. Aluminum Step Ladder - Extrusion:

The side supports of this ladder are made from extruded aluminum sections. They are shaped in such a way to improve the strength of the sections. The rungs of the ladder are also extruded sections. They are provided with ribs. The cost of the ladder drops down considerably since most of the construction is of extruded aluminum.

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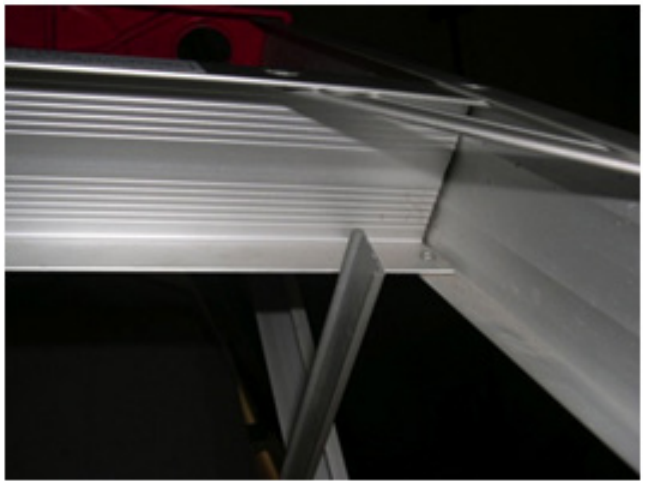
The top of the ladder, the platform as well as the bottom pads is made of injection-mouldedpolypropylene. It not only provides a soft padding, but also adds to the aesthetic appeal of the ladder by giving it a touch of color. The top has conveniently placed holes for hanging tools or brushes. The platform has been joined to the aluminum section by simply making a cut in it and bending the aluminum to make a hinge with the help of a rivet.



The top and bottom rung are provided with extra support as seen in the photograph. Rivets do the fastening in all cases. The rivets are rounded off at the inside so that there are no flared sharp ends to harm the aluminum or the plastic.

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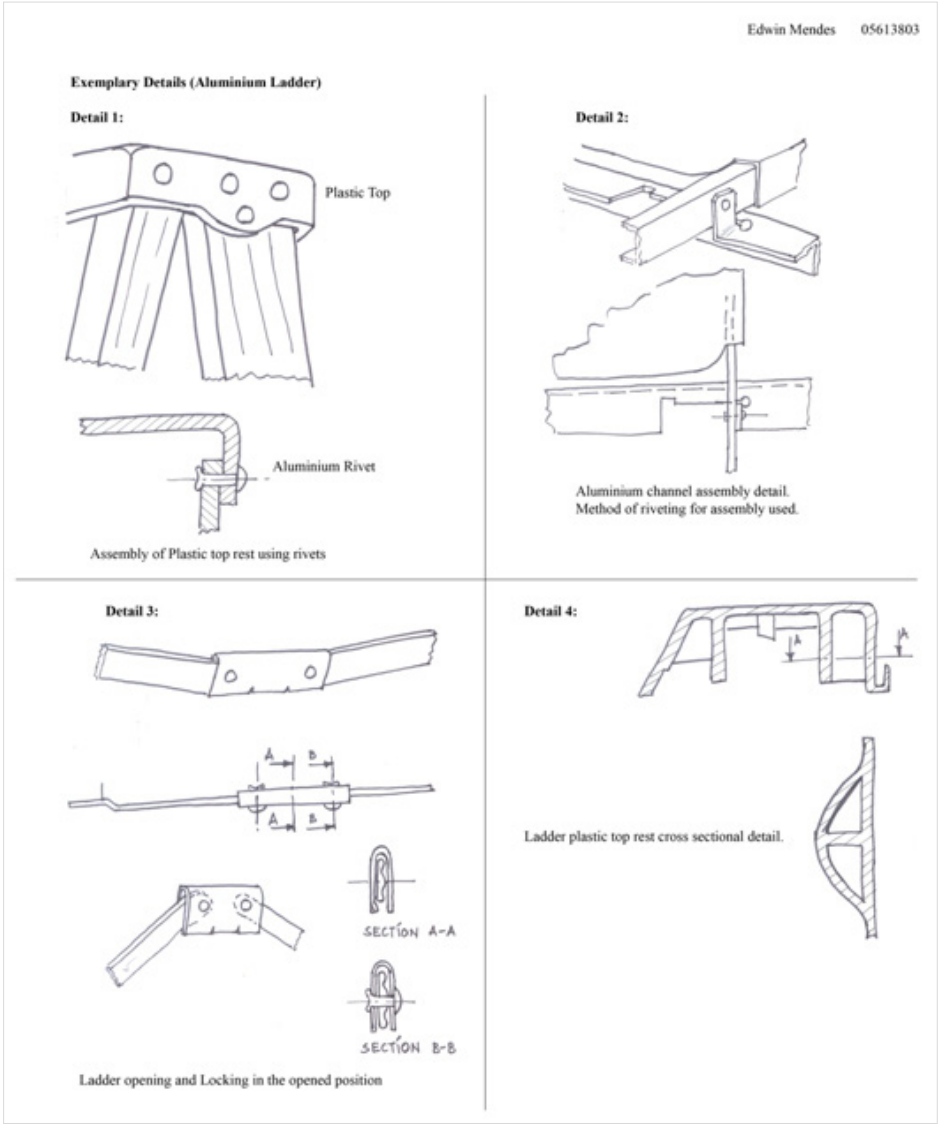
Student Assignment:



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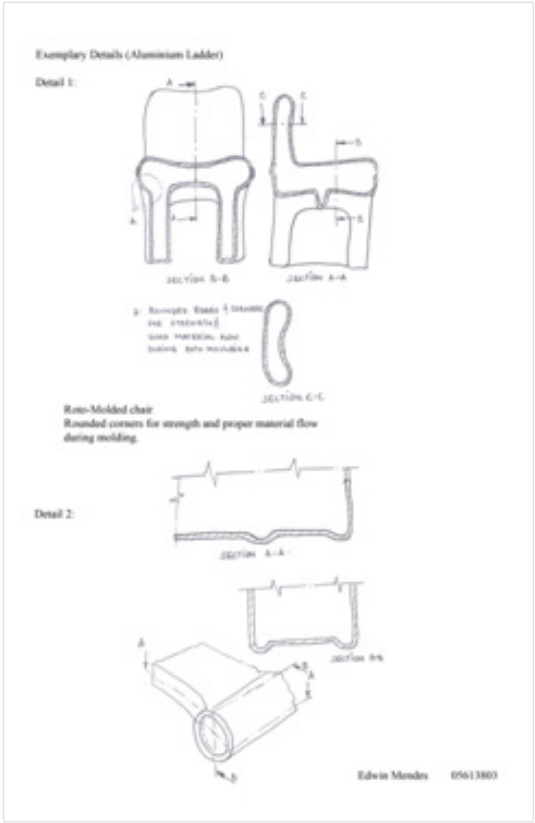
b. Polyethylene Chair - Rotomoulding:

This chair is made of polyethylene, a very conducive material for rotomoulding and blow molding. Polyethylene flows easily and doesn't cool too quickly, thus enabling complex shapes to be made in roto and blow molding processes. The parting line is taken such that it comes on the ridge of the seat, thus hiding the parting line. The ridges at the bottom of the seat and the base of the legs are provided for extra support and strength.

Student Assignment:



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c. Polyethylene Toy - Blow Molding:

The individual blocks on the train are made or blow molded polyethylene. The kind of locking between two blocks used here is very easily achieved in blow molding, since the part itself is slightly compressible by virtue of it being filled with air. The wheels of the train are injection-molded polypropylene. They have ribs and a hub to give it more rigidity.

d. Polypropylene Child carrying bicycle seat - Injection Molding:

The seat is made from polypropylene by injection molding. Since safety is the main issue in this case, there are numerous belts and clasps provided on the seat. The seating is on a removable foam seat for added comfort and is joined to the plastic seat with Velcro.

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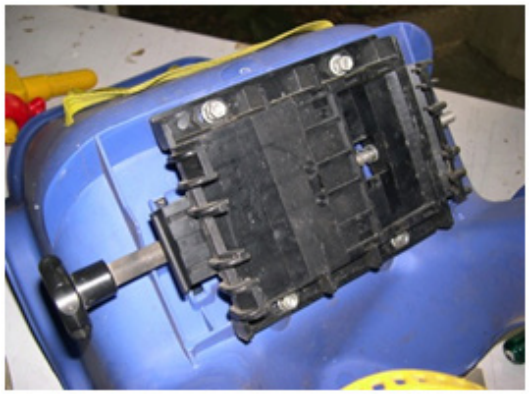

The part where the seat will get attached to the bicycle is made of nylon and has a double locking mechanism. The leg guards are made from soft polypropylene for comfort and joined to the main seat with the help of rivets. The injection-molded seat is given broad radii protruding lips at the arms aiming at increasing strength as well as comfort. There are no ribs provided at the base of the back, which caused the plastic at the joint there to be stressed due to fatigue. e.

e. Polyethylene Suitcase - Injection Molding:

The suitcase is made of injection-moldedpolyethylene, which is an excellent material for injection molding. The wheels have nylon bearings inside them. This gives them rotational as well as rolling motion, making it easier to pull the suitcase.

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The various fittings on the suitcase are also injection molded, either in polypropylene or polyethylene. The cord for pulling the suitcase is joined to a coil spring. The entire spring mechanism is encased in a chamber made of polypropylene with a live hinge. The two parts of the suitcase fit each other in a special groove made in the bottom half.

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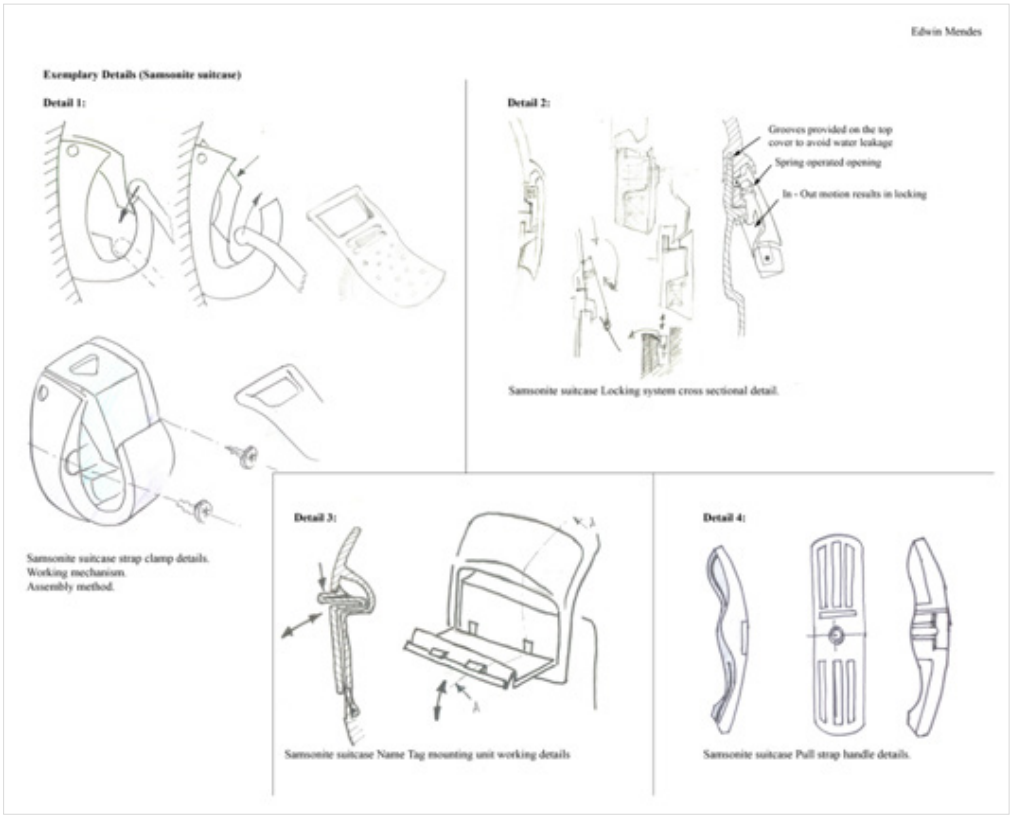
Edwin Mendes
Exemplary Details (Samsonite suitcase)
Detail 1:
Detail 2:
Grooves provided on the top cover to avoid water leakage
Spring operated opening
In - Out motion results in locking
Samsonite suitcase Locking system cross sectional detail.
Samsonite suitcase strap clamp details.
Working mechanism.
Assembly method.
Detail 3:
Samsonite suitcase Name Tag mounting unit working details
Detail 4:
Samsonite suitcase Pull strap handle details.

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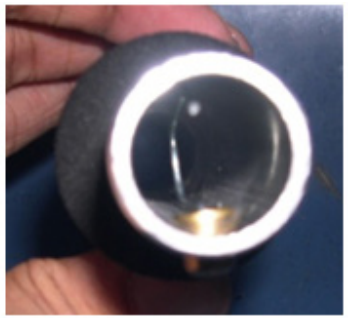
Aluminum Scooter - Extrusion and Die Casting:



This two-wheeled scooter is made mostly from aluminum. The handle is made of aluminum pipes with a cross-section, which enables the two parts to be assembled in only one orientation. The fork between the handle and the handlebars is made of pressure die cast aluminum. The handlebars are pipes with foam grips, which are extrusion molded. The fixing mechanism is a spring-loaded button, which snaps into holes provided on the fork.

The rod, which connects the handlebar to the wheel fork, is made of extruded aluminum sections. The cross section of these is as shown. They slide into each other, thus enabling the length of the rod to be adjusted.

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The part, which tightens the rod at its extreme position, is a lever with a cam profile at one end. The rod can thus be extended when needed and retracted when the scooter needs to be folded and stored.

The wheels are made of nylon for minimum friction. The front wheel is attached to a fork. Since this fork takes a large amount of stress, it is made of steel with a brushed finish.

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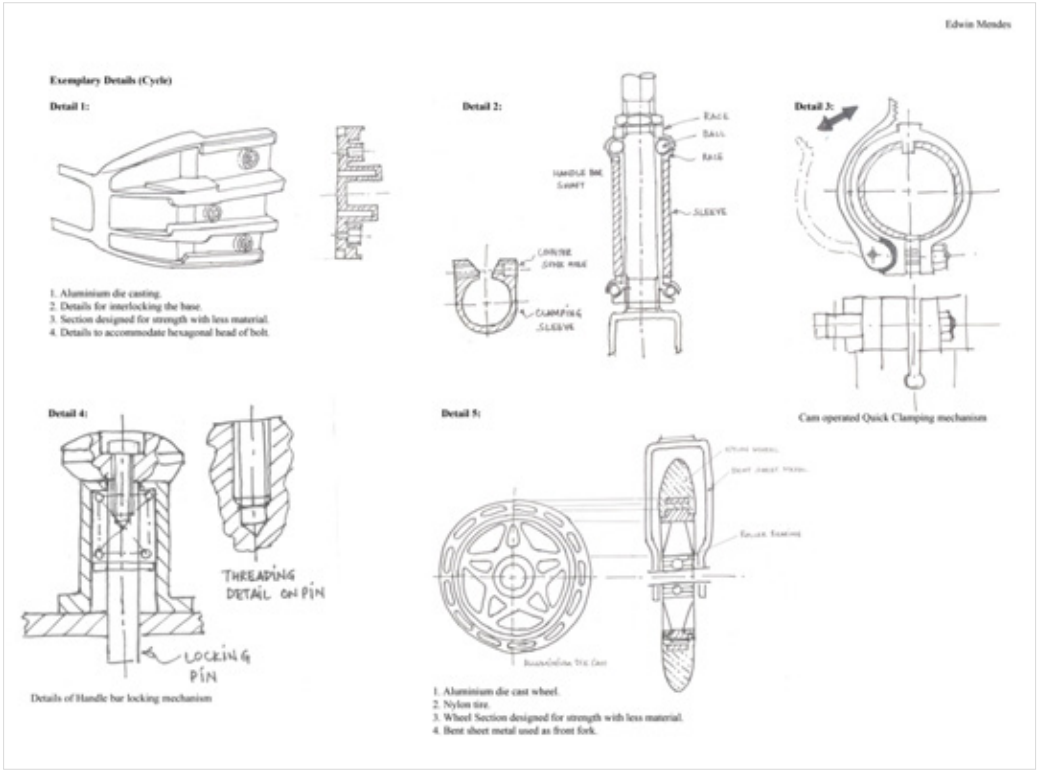
The back wheel has a brake attached to it. The brake consists of a metal mud-guard with a helical spring. To apply the brake the metal part is simply depressed causing friction with the wheel.

The base is made of a central extruded aluminum section. At both sides it is capped by pressure die cast aluminum parts. These cast parts are provided with two levels so that the base level of the platform remains constant even after joining. Fastening is mainly done with nut-bolts.

Student Assignment:


Edwin Mendes
Exemplary Details (Cycle)
Detail 1:
1. Aluminium die casting.
2. Details for interlocking the base.
3. Section designed for strength with less material.
4. Details to accommodate hexagonal head of bolt.
Detail 2:
Detail 3:
Cam operated Quick Clamping mechanism
Detail 4:
THREADING DETAIL on PIN
LOCKING PIN
Details of Handle bar locking mechanism
Detail 5:
1. Aluminium die cast wheel.
2. Nylon tire.
3. Wheel Section designed for strength with less material.
4. Bent sheet metal used as front fork.

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Products Featuring Innovative Materials

This is a study for students to identify use of innovative materials and manufacturing processes in new product design. The class discussion helps to understand how boundaries of existing material and processes are broken to come up with innovative applications.

1. Danish Design firm PAPCoRN's Design:

The elegant, disposable dishes are made from Bioplast, a corn-based plastic that breaks down in a matter of months instead of centuries.

2. Product designed by Marcel van Galen:

A new over molding process that allows high-volume production of plastic parts bonded to fabric, leather, wood, metal or other materials.

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3. Realistic Reebok Shoe Sole Printed on 3D Printer:

Prototypes like this running shoe sole in high-definition plastics that define color to reflect original design data and to make sure models accurately communicate the design intent.

4. Designs of ART CENTER COLLEGE student - Ana Franco:

The piece is a environment friendly chair made of high quality environment friendly plastic.

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5. Designs of ART CENTER COLLEGE student - Wen Yo Lu:

A combination stroller, child's car seat, and pogo stick, a product that has a long life span - specifically to extend the life of one product to save materials, cost, etc.

6. Designs of ART CENTER COLLEGE student - Paul Fu:

High quality food grade plastics are used in this product.

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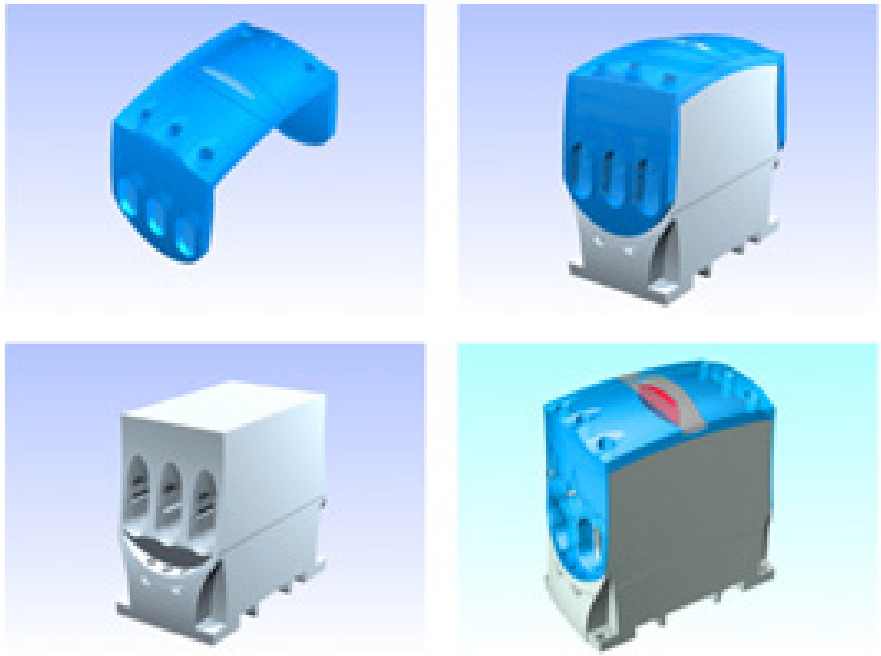
7. Design IDC – IIT Bombay:



Next generation contactor using Nylon 66 grade Dupont 74/33L for body and polycarbonate GE Valox 143 R for the Translucent cover.

Design Course

Materials and Processes

The Science of Material Selection

by
Prof. B. K. Chakravarthy
IDC, IIT Bombay

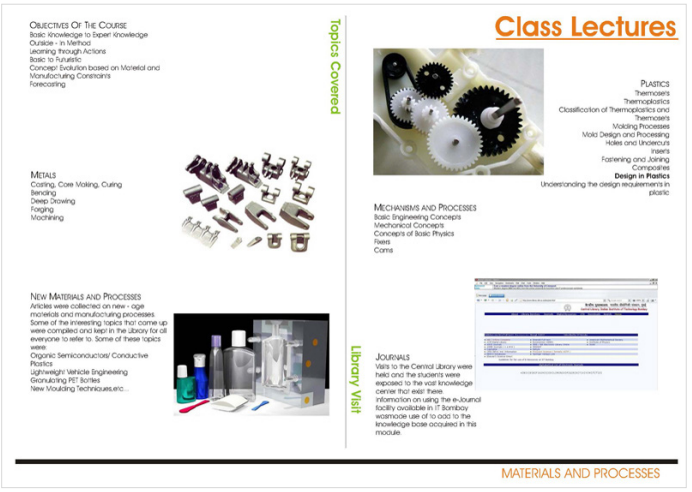
Source:
https://www.dsource.in/course/materials-and-processes/summary

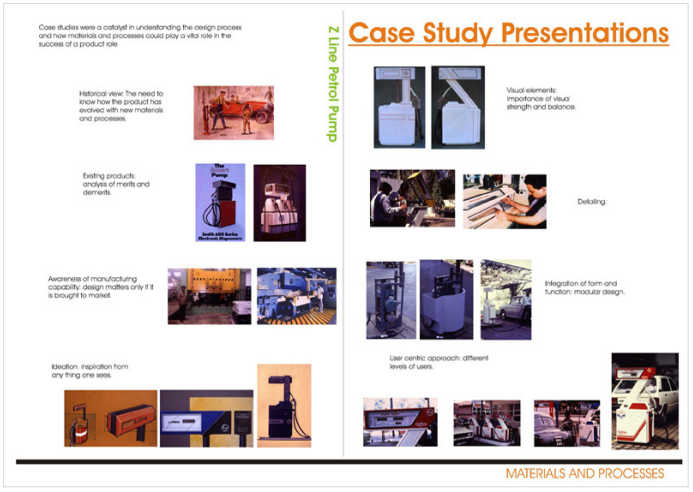
1. Introduction
2. Case Studies
3. Industry Visit
4. Studio Assignments
5. Products Featuring Innovative Materials
6. Summary
7. Contact Details

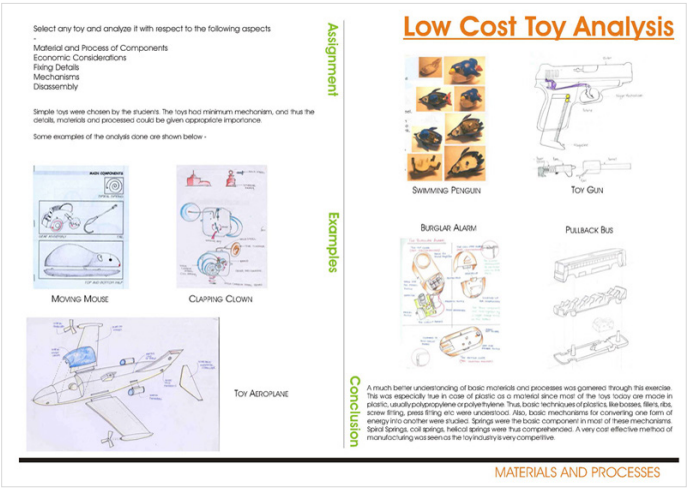
Summary

The Summary of the Course Contents is given below:

Materials and Processes
ID 647
1. Class Lectures
Study of Plastic and Plastic Processes
Study of Ferrous and Non-Ferrous Metals
Study of Mechanisms and Linkages
Design in Plastic
Basics of Design and Technology
2. Case Study Presentations
Z-line Petrol Pump
Post Box Design
Samsonite Suitcase
Back Hoe Loader
3. Studio Assignments
Low Cost Toy Analysis: Focus on Economic Considerations
Vehicle Disassembly:
Comparison of materials across different vehicles
Study of various elements like chassis, seat and fixing details
Application Development in stainless steel
4. Central Library Assignment
Use of futuristic materials in new products
Scanning all journals and online journals
5. Design of Products for Materials
Redesign of an existing product in five different materials with focus on change in design due to change of material
6. Industrial Visits
Plywood Industry
Rubber Industry
Plastic Industry
Godrej
Mahindra and Mahindra
Midco
MATERIALS AND PROCESSES







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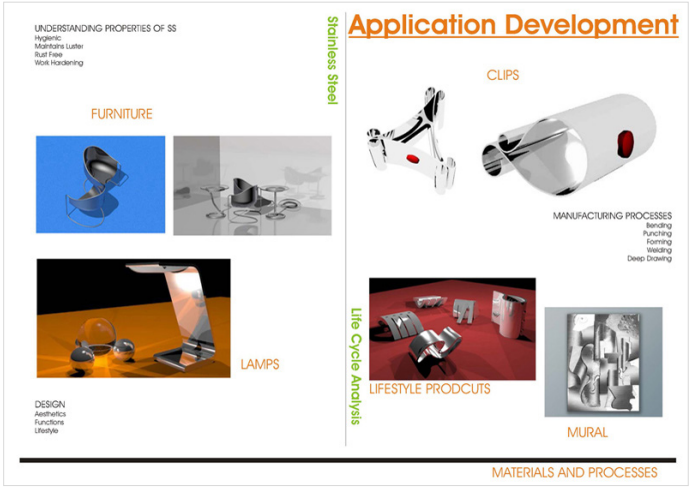

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Contact Details

This documentation for the course was done by Professor. B. K. Chakravarthy at IDC, IIT Bombay.

You can get in touch with him at chakku[at]iitb.ac.in

You can write to the following address regarding suggestions and clarifications:

Helpdesk Details:
Co-ordinator
Project e-kalpa
Industrial Design Centre
IIT Bombay
Powai
Mumbai 400076
India

Phone: 091-22-2159 6805/ 091-22-2576 7802
Email: dsource.in[at]gmail.com